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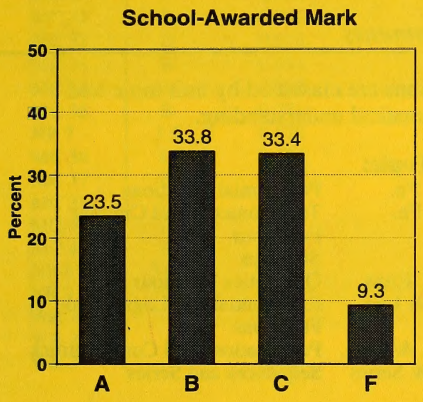
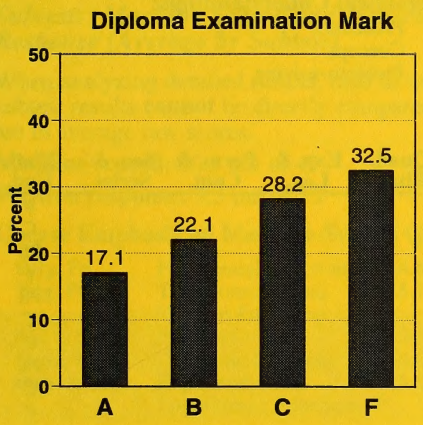
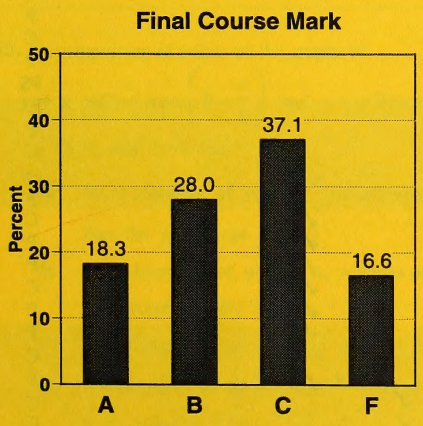
Mathematics 30

Diploma Examination Results
Examiners' Report for June 1997







The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the June 1997 administration of the Mathematics 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined November, January, June, and August results is made available annually.

Description of the Examination

The Mathematics 30 Diploma Examination consists of 40 multiple-choice questions worth 57.1%, nine numerical-response questions worth 12.9%, and three written-response questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 8 719 students who wrote the June 1997 examination.

- 83.4% of the 8 719 students achieved the acceptable standard (a final course mark of 50% or higher).
- 18.3% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 50.9% of the students who wrote the June 1997 examination were female.

- 82.9% of the female students achieved the acceptable standard (a final course mark of 50% or higher).
- 17.0% of these female students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 49.1% of the students who wrote the June 1997 examination were male.

- 83.9% of the male students achieved the acceptable standard (a final course mark of 50% or higher).
- 19.6% of these male students achieved the standard of excellence (a final course mark of 80% or higher).

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Student Evaluation

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Provincial Averages

- The average school-awarded mark was 67.3%.
- The average diploma examination mark was 59.2%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 63.5%.

Of the 8 719 students who wrote the June 1997 examination, 1 602 had written at least one Math 30 exam previously.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It was designed so that students who are achieving the acceptable standard should obtain a mark of 50% or higher and students achieving the standard of excellence should obtain a mark of 80% or higher.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For multiple-choice, numerical-response and written-response questions, the "Difficulty" indicates the proportion (out of 1) of students answering the question correctly.

Questions are classified by unit topic and mathematical understanding.

Unit Topic:

Poly. Fn.	Polynomial Functions
Trig. Fn.	Trigonometric and Circular Functions
Stat.	Statistics
Quad. Rltns.	Quadratics Relations
Exp. & Log.	Exponential and Logarithmic Functions
Perm. & Com.	Permutations and Combinations
Seq. & Series	Sequences and Series

Mathematical Understandings:

P	Procedure
C	Concept
PS	Problem-solving

Blueprint

Question	Key	Difficulty	Poly. Fn.	Trig. Fn.	Stat.	Quad. Rltns.	Exp. & Log.	Perm. & Com.	Seq. & Series	Math Und.
MC 1	B	0.870			✓					P
MC 2	D	0.859			✓					C
MC 3	A	0.670			✓					PS
NR 1	7.5	0.630			✓					P
MC 4	C	0.804	✓							PS
MC 5	C	0.771	✓							C
MC 6	A	0.527	✓							C
MC 7	B	0.569	✓							PS
MC 8	A	0.337	✓							C
MC 9	A	0.633	✓							P
MC 10	C	0.746	✓							C
NR 2	1.8	0.432	✓							P
MC 11	C	0.779		✓						C
MC 12	D	0.869		✓						P
MC 13	D	0.774		✓						PS
MC 14	B	0.476		✓						PS
MC 15	B	0.508		✓						P
MC 16	A	0.618		✓						C
NR 3	36.9	0.431		✓						PS
NR 4	105	0.661		✓						P
MC 17	A	0.900					✓			C
MC 18	B	0.779					✓			P
MC 19	C	0.516					✓			P
MC 20	A	0.467					✓			C
MC 21	C	0.831					✓			P
MC 22	B	0.723					✓			P
MC 23	C	0.734					✓			C
NR 5	4.0	0.608					✓			P
MC 24	C	0.801				✓				C
MC 25	A	0.743				✓				C

Question	Key	Difficulty	Poly. Fn.	Trig. Fn.	Stat.	Quad. Rltns.	Exp. & Log.	Perm. & Com.	Seq. & Series	Math Und.
MC 26	D	0.529				✓				C
MC 27	C	0.573				✓				P
MC 28	C	0.811				✓				PS
MC 29	D	0.393				✓				P
NR 6	18.0	0.181				✓				PS
MC 30	A	0.538							✓	PS
MC 31	B	0.762							✓	P
MC 32	D	0.658							✓	PS
MC 33	B	0.694							✓	PS
MC 34	A	0.639							✓	P
MC 35	B	0.771							✓	P
NR 7	3.5	0.578							✓	PS
MC 36	D	0.536						✓		C
MC 37	B	0.697						✓		C
MC 38	C	0.567						✓		PS
MC 39	D	0.455						✓		P
MC 40	B	0.536						✓		P
NR 8	540	0.308						✓		P
NR 9	101	0.522						✓		P
WR 1	–	0.562								PCPS
WR 2	–	0.540								PCPS
WR 3	–	0.406								PCPS

Subtests: Machine Scored and Written Response (Average by Subtest)

When analyzing detailed results, bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Machine scored: 30.8 out of 49

Written response: 7.5 out of 15

Course Emphasis on Machine-Scored Questions

Poly. Fn	Polynomial Functions	4.8 out of 8
Trig. Fn	Trigonometric and Circular Functions	5.1 out of 8
Stat	Statistics	3.0 out of 4
Quad. Rltns	Quadratic Relations	4.0 out of 7
Exp. & Log.	Exponential and Logarithmic Functions	5.6 out of 8
Perm. & Com.	Permutations and Combinations	3.6 out of 7
Seq. & Series	Sequences and Series	4.6 out of 7

Mathematical Understandings* on Machine-Scored Questions

- Procedural (P): 13 out of 21
- Conceptual (C): 10 out of 15
- Problem Solving (PS): 7.8 out of 13

* Refer to Appendix C of the 1996–97 *Mathematics 30 Information Bulletin, Diploma Examinations Program,* for an explanation of mathematical understandings.

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13. A comparison of points on the graphs of

$y = p(\theta) = a\cos\left(\theta - \frac{\pi}{2}\right)$ and $y = q(\theta) = k\cos(\theta)$, $a \neq k$, would show that

A. the y-intercept of $p(\theta)$ is $\frac{\pi}{2}$ units lower than the y-intercept of $q(\theta)$

B. the y-intercept of $p(\theta)$ is a, whereas the y-intercept of $q(\theta)$ is k

C. the θ-intercepts of $p(\theta)$ and $q(\theta)$ are the same

•D. the θ-intercepts of $p(\theta)$ are $\frac{\pi}{2}$ units to the right of the θ-intercepts of $q(\theta)$

Multiple-Choice and Numerical-Response Questions

The multiple-choice and numerical-response sections of the examination comprise questions that sample all content areas in Mathematics 30. A discussion of students' achievement of the curriculum standards in the units Trigonometric and Circular Functions, and Sequences and Series follows.

Trigonometric and Circular Functions — In order to achieve the curriculum standards for this unit, students should be able to convert the angle measurements between degree and radian measure, verify the fundamental trigonometric identities, solve first-degree trigonometric equations on the domain $0 \leq \theta < 2\pi$ in radians and

Use the following information to answer the next question.

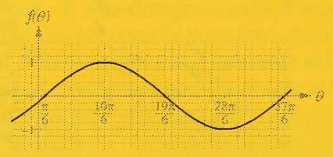
A student graphed a function of the form of

$$f(\theta) = a \sin[b(\theta + c)],$$

where $a > 0$ and $b > 0$,

on a computer. The computer display, where θ is measured in radians, is shown below. The graph crosses the θ-axis at

$$\frac{\pi}{6}, \frac{19\pi}{6}, \frac{37\pi}{6} \ldots$$



14. The value of b is

A. $\frac{1}{6}$

•**B.** $\frac{1}{3}$

C. 3

D. 6

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30. The sequence $\log(a^3)$, $\log(a^5)$, $\log(a^7)$, $a \neq 1$, is

•**A.** an arithmetic sequence with a common difference of $2\log(a)$

B. an arithmetic sequence with a common difference of $\log(2a)$

C. a geometric sequence with a common ratio of $2\log(a)$

D. a geometric sequence with a common ratio of $\log(2a)$

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35. If the sum of the first 5 terms of a geometric series is 410 and the common ratio is $-\frac{1}{4}$, then the first term is

A. 81.5

•**B.** 512

C. 1 024

D. 104 960

$0° \leq \theta < 360°$, and simplify and evaluate simple trigonometric expressions involving the fundamental trigonometric identities. Students should also be able to generate the graph of trigonometric functions with the use of graphing calculators or graphing utility packages and, explain the effect of each parameter a,b,c, and d on the graphs of the functions $y = a \sin[b(\theta + c)] + d$ and $y = a \cos[b(\theta + c)] + d$. In addition, students should be able to state the domain and range of y=sin θ, y=cos θ, and y= tan θ and describe, orally and in writing, the relationship between the root(s) of a first-degree trigonometric equation and the graph of its corresponding function, as well as participate in and contribute toward the problem-solving process for problems that can be represented by trigonometric functions studied in Mathematics 30. Multiple-choice questions 11 to 16 and numerical-response questions 3 and 4 required students to demonstrate their understanding of this unit. Of the students who achieved the acceptable standard but not the standard of excellence, 83.3% answered question 13 correctly and 47.7% answered question 14 correctly.

Students who achieve the standard of excellence are expected to be able to prove trigonometric identities and to explain, orally and in writing, the combined effects of the parameters $a,b,c,$ and d in the trigonometric functions $y = a \sin[b(\theta + c)] + d$ and $y = a \cos[b(\theta + c)] + d$ on the functions' domain and range. They are also expected to solve first- and second-degree trigonometric equations, including double- and half-angles on the domain $0 < \theta \leq 2\pi$ or $0° \leq \theta < 360°$, as well as describe, orally and in writing, the relationship between the root(s) of a trigonometric equation and the graph of its corresponding function, and complete solutions to problems that can be represented by trigonometric functions studied in Mathematics 30. Multiple-choice questions 13 and 14 required students to show that they can do this. Of the students who achieved the standard of excellence on the examination, 94.3% answered multiple-choice question 13 correctly and 83.7% answered multiple-choice question 14 correctly. Multiple-choice questions 11, 12, 15, and 16, and numerical-response questions 3 and 4 identified expectations for those students who achieved the acceptable standard but not the standard of excellence; over 91% of students who achieved the standard of excellence on the examination were able to successfully achieve the expectations of these questions.

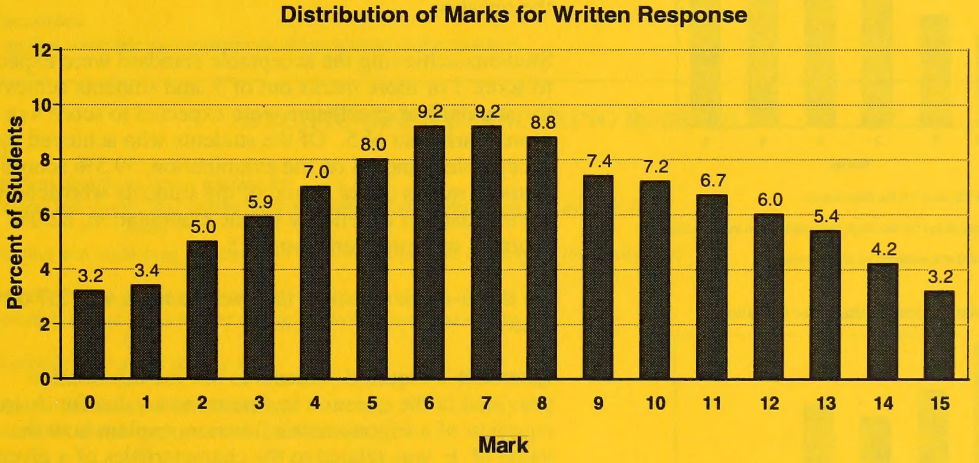
Sequences and Series — To achieve the acceptable standard in sequences and series, students must be able to write the specific terms of a sequence, given its defining function; expand a series given in sigma notation; describe, orally and in writing, the difference between sequences and series, arithmetic and geometric, infinite and finite; and, apply the general term "formula" to arithmetic and geometric sequences. They must also be able to apply

the sum formula for arithmetic and geometric series and be able to participate in and contribute toward the problem-solving process for problems involving sum and term formulas for arithmetic and geometric series and sequences studied in Mathematics 30. Multiple-choice questions 30 to 35 and numerical-response question 7 required students to demonstrate their understanding of this unit. Of the students who achieved the acceptable standard but not the standard of excellence, 50.1% correctly answered multiple-choice question 30 and 85.0% correctly answered question 35.

In addition to the expectations for the acceptable standard, students who achieve the standard of excellence must be able to solve problems using the general term and/or sum formulas in which there are two unknowns, write the specific terms of a sequence when given its recursive definition, determine the functions describing any sequence that has a recognizable pattern, and complete the solution to problems involving sum and term formulas for arithmetic and geometric series and sequences studied in Mathematics 30.

Written-Response Questions

As published in the 1995–96 and 1996–97 *Mathematics 30, Diploma Examination Information Bulletin*, the written-response questions assess whether or not students can draw on their mathematical experiences to solve problems and to explain mathematical concepts. Therefore, the written-response questions do not necessarily fall into a particular unit of study but may cross more than one unit or may require students to make connections among mathematical concepts. Students achieving the acceptable standard are expected to obtain at least half marks on all questions. Students achieving the standard of excellence are expected to answer all questions almost perfectly.



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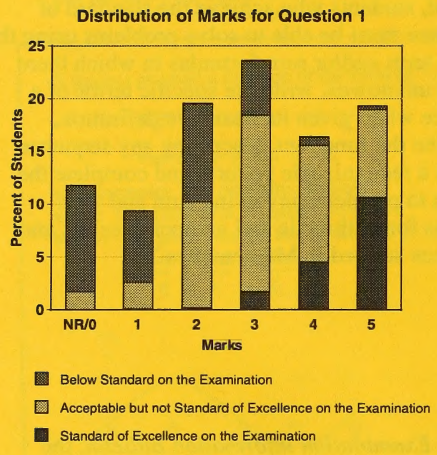

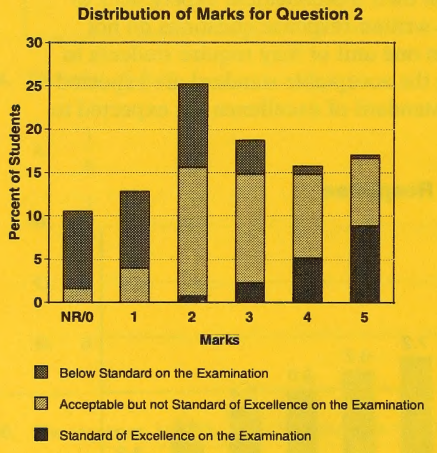

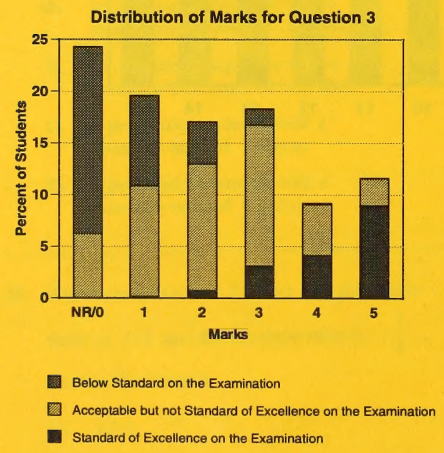

Question 1 required students to correctly sketch the graphs of two polynomials that satisfied given conditions, determine the equation of one function P, and predict differences in the values of the x and y-intercepts if an incorrect value of k had been calculated.

It was expected that students achieving the acceptable standard would score 3 out of 5 marks. Of the students who met the acceptable standard of achievement on the examination, 71.7% received at least 3 out of 5 marks, and of students who achieved the standard of excellence on the examination, 88.5% scored 4 or more marks out of 5.

On this 5-mark question, the average mark was 2.8 or 56.3%.

Question 2 required students to determine the number of complete swings in a full ride of a children's ride that was modelled after a basic pendulum design, given certain conditions in the question. In addition, students had to determine the total distance a rider would travel during a specified number of swings and determine the probability of a passenger having to wait longer than a given amount of time to purchase a ticket, given specific relevant data in the question.

Students achieving the acceptable standard were expected to score 3 or more marks out of 5, and students achieving the standard of excellence were expected to score 4 or more marks out of 5. Of the students who achieved the acceptable standard on the examination, 59.5% scored 3 or more marks out of 5, and of the students who achieved the standard of excellence on the examination, 82.0% scored 4 or more marks out of 5.

On this 5-mark question, the average mark was 2.7 or 53.5%.

Question 3 required students to use the information provided in the question to determine a value for b in the equation of a trigonometric function, explain how the value of b was related to the characteristics of a given graph of the function, and, using the previously determined value for b, prove a trigonometric identity.

Of the students who achieved the acceptable standard on the examination, 42.1% scored 3 or more marks out of 5, and of the students who achieved the standard of excellence on the examination, 76.6% scored 4 or more marks out of 5.

On this 5-mark question, the average mark was 2.1 or 40.7%.

Scoring Guide for Written-Response Questions

Credit may be given to students who show unusual insight. If their solutions fall outside *Specific Question Scoring Rubrics*, they were scored against the *General Scoring Guide* shown below.

GENERAL SCORING GUIDE

5 marks The student
- demonstrates a *complete understanding* of the problem
- uses mathematical knowledge and problem-solving techniques to find the solution
- justifies the solution and explained its relevance to the problem

4 marks The student
- demonstrates *an understanding* of the problem
- chooses a strategy that used mathematical knowledge and problem-solving techniques to find a solution, but the procedure contains *a minor flaw*
- shows *some justification* of his or her results

3 marks The student
- demonstrates *some understanding* of the problem
- formulates *some aspects* of the problem mathematically
- demonstrates the use of a strategy that uses mathematical knowledge and problem-solving techniques to find a *partial* solution
- communicates little understanding of the complexities of the problem

2 marks The student
- explores the *initial stages* of the problem
- applies *some* relevant mathematical knowledge and problem-solving techniques to find a *partial* solution

1 mark The student
- applies some relevant mathematical knowledge to the problem

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SPECIFIC QUESTION SCORING RUBRICS

Question 1

5 The student obtains a correct solution by
- sketching two graphs that satisfy the given conditions, determining an equation for P,

AND
- predicting and explaining no change to the x-intercepts and a change to the y-intercept

4 The student finds a solution that contains a minor flaw such as
- the predictions are given but are wrong or have no explanation

OR
- an algebraic error while solving for k

3 The student obtains a partial solution by
- successfully completing two out of three bullets

OR
- sketching one graph that satisfies the given conditions, and the corresponding equation

OR
- sketching both graphs, attempting to find an equation with a correct procedure, and providing one reasonable prediction

2 The student explores initial stages to find partial solution by
- successfully completing one out of three bullets

OR
- giving predictions with a partial explanation

1 The student only explores initial stages by
- sketching one graph that satisfies the given conditions

OR
- writing $P(x) = k(x + 3)^2(x - 1)$ or $P(x) = k(x + 3)(x - 1)^2$, demonstrating the correct relation between a factor and an x-intercept

OR
- giving one or two predictions that are wrong or have no explanation

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Question 2

5 The student obtains a correct solution by
- determining the total number of swings is 28 ; the distance travelled after 15 swings is 784 m; and the probability that you wait more than 45 minutes is 0.1056

4 The student provides/obtains a solution that contains a minor flaw; for example,
- stating 27 complete swings

OR
- not substracting 0.3944 from 0.5

3 The student obtains a partial solution by
- correctly completing two bullets

OR
- correctly completing one bullet and making good progress on the other two

2 The student explores initial stages to find partial solutions by
- correctly completing any bullet

OR
- making some progress on all bullets

1 The student only explores initial stages

Question 3

5 The student obtains a solution
- correctly completing all the bullets

4 The student
- successfully completes the first two bullets and continues the proof beyond the initial stages

OR
- obtains a solution that contains a minor flaw

3 The student obtains a partial solution by
- determining $b = 2$ and by explaining how the value of b is related to the characteristics of the graph

OR
- correctly completing the proof

OR
- determining $b = 2$, showing some understanding of how b relates to the graph, and completing an initial stage of the proof

OR
- explaining how the value of b is related to the characteristics of the graph and continuing the proof beyond the initial stage

2 The student explores initial stages to find a partial solution by
- determining $b = 2$ and showing some understanding of how b relates to the graph

OR
- determining $b = 2$ or showing some understanding of how b is related to the graph, and completing an initial stage of the proof

OR
- continuing the proof beyond the initial stage

OR
- explaining how the value of b is related to the characteristics of the graph

1 The student only explores initial stages by
- determining $b = 2$

OR
- attempting to connect b with the period

OR
- factoring $\cos^4\theta - \sin^4\theta$

For further information, contact Marion Florence (mflorence@edc.gov.ab.ca) or Phill Campbell (pcampbell@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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